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Electrical Installation

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ABSTRACT

It's a fact and reality that electricity is essential for all kind of sectors, whether it is a house, factory, industry, airports or whatever! Electricity is demanded by everyone all around the GLOBE!

The aim of this project is to show the phases and steps of the installation of electricity which is coming from the power station through the transmission lines, that is to say that the chapter explains that how we are using electricity so easily and comfortably at home, for example we just press the switch & the lamp just turns on, the projects explains this phenomena by explaining about the cables connected between the switch and the lamp. Many other similar concepts are also described in the project.

This electrical installation project is of a two floor building situated in Nicosia. Each floor has two apartments so in total it becomes four apartments, all the apartments have the same dimensions.

This project presents the installation design of particular building; the design includes the switches, water heater, water motor, lamps, distribution boards, main board & etc.

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INTRODUCTION

In our homes, electricity runs the lights, television, toaster, and more. It's hard to even imagine what your life would be like without electricity….

It's easy to see what electricity does for us, but what IS electricity? Electricity is a form of energy. Energy is power…the power to do and move things, and to make things work. Electricity is the flow of electrical power or charge. It is a secondary energy source which means that we get it from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary sources.

Electricity is a basic part of nature and it is one of our most widely used forms of energy. Many cities and towns were built alongside waterfalls (a primary source of mechanical energy) that turned water wheels to perform work. Before electricity generation began slightly over 100 years ago, houses were lit with kerosene lamps, food was cooled in iceboxes, and rooms were warmed by wood-burning or coal-burning stoves.

Despite its great importance in our daily lives, most of us rarely stop to think what life would be like without electricity. Yet like air and water, we tend to take electricity for granted. Everyday, we use electricity to do many jobs for us -- from lighting and heating/cooling our homes, to powering our televisions and computers. Electricity is a controllable and convenient form of energy used in the applications of heat, light and power.

When we mention electrical energy, three; important parameter come into mind. These are producing electricity, transmitting and its distribution.

In this project we are going to discuss the distribution of electricity coming from network, tools to be used during this distribution process, calculations done, devices and conductor type to be employed and in addition to this we will cover the material and techniques that will project the people and the business in terms of monetary and physical damage, plus the fuse earth processes will be explained.

This project is specific to a two floor building situated in Nicosia, each floor has two apartments and more details will be given in the later chapters.

To sum up, after doing necessary calculations and initial work, the building's internal electrical installation design is drawn by the help of AutoCAD.

The entire topic discussed above is described & explained through out this project.

1- ELECTRICAL INSTALLATION

1.1 Overview

This chapter will present what is electrical installation and why it is done. The general laws, standards and regulation of electrical installation

1.2 Concept of Electrical Installation

At the electric distribution substation that serves our homes, the electricity is removed from the transmission system and passed through step-down transformers that lower the voltage. The electricity is then transferred onto your local electric co-op's network of distribution lines and delivered to your home. There, the electricity's voltage is lowered again by a distribution transformer and passed through your electric meter into your home's network of electric wires and outlets. So now the electrical energy is at our door step, but it cannot be used with installation of different devices, such as distribution box switches, lamps, ceiling roses etc, so simply we feel need of installation of all those equipment so we can use electricity for our daily life. So “Electrical installation" means the wires, machinery, apparatus, appliances, devices, material and equipment used or intended for use by a consumer for the distribution or use of electrical power or energy

1.3 Electricity Installation Acts

The following mention acts are some general Acts used all around the world.

- "Approved" means approved by the Chief Inspector or of a standard approved by the Chief Inspector;

- "Chief Inspector" means the Chief Inspector appointed under this Act;

- "Consumer" means any corporation, commission, company, person, association of persons, or their lessees, trustees, liquidators or receivers, utilizing or intending to utilize electrical power or energy directly for any purpose including heat, light or power purposes.

- "Fire Marshal" means the Fire Marshal appointed under the Fire Prevention Act;

- "contractor" means any person, corporation, company, firm, organization or partnership performing or engaging to perform, either for his or its own use or benefit, or for that of another and with or without remuneration or gain, any work with respect to an electrical installation or any other work to which this Act applies, but does not include a public utility as defined in this Act.

- "Electrical installation" means the wires, machinery, apparatus, appliances, devices, material and equipment used or intended for use by a consumer for the receipt, distribution or use of electrical power or energy;

- "Public utility" includes any corporation, commission, company, person, association of persons, or their lessees, trustees, liquidators or receivers, that own or hereafter own or may own, operate, manage or control or may be incorporated for the purpose of owning, operating, managing or controlling any plant or equipment for the production, transmission, delivery or furnishing of electrical power or energy for any purpose including heat, light or power purposes, either directly or indirectly to or for the public.

1.4 Regulations and Inspection

- With the approval of the Governor in Council, the Fire Marshal may make regulations respecting electrical installations for the purpose of preventing fire and injury to persons and property including, without restricting the generality of the foregoing, regulations.

- Prescribing the duties of inspectors and regulating their conduct while in the discharge of their duties.

- Respecting the granting of permission for the connection, including temporary connection, of any electrical installation to sources of electrical power or energy.

- Providing for the issuing of certificates of approval or permits for anything approved or done or permitted to be done under this Act or the regulations.

- Regulating, controlling or prohibiting the installation, erection, use, sale or other disposal of electrical materials and equipment within the Province.

- Prescribing that no contractor shall carry on business in any area of the Province designated in the regulations unless the contractor holds a license under the regulations.

- Respecting the licensing of contractors including the form, content and duration of licenses, the revocation or suspension of licenses;

- Prescribing the manner of giving and serving notices and orders given or issued under this Act or the regulations.

- Respecting the granting of extensions of time for anything required to be done under this Act or the regulations.

- Exempting any electrical installation from the provisions of this Act.

- Providing for procedures for the inspection of an electrical installation or an alteration or addition to an electrical installation.

- Exempting a public utility or an inspector from the inspection of an electrical installation, alteration or addition to an electrical installation;

- Respecting the inspection of electrical installations and alterations or additions to electrical installations.

- Subject to the regulations, every public utility or an inspector shall inspect the electrical installation of a consumer applying for a supply of electrical power or energy.

- Where the electrical installation does not conform to the regulations, the public utility or an inspector shall so notify the consumer and the contractor, specifying wherein the electrical installation does not so conform, and the public utility shall not make a connection nor be required to make a connection with the electrical installation nor supply any electrical power or energy to the consumer until the electrical installation is in conformity with the regulations.

- Where a public utility or an inspector has reason to believe that an electrical installation may not conform to the regulations, the public utility or the inspector may inspect the electrical installation.

- Where an inspection is made and the public utility or the inspector is of the opinion that the electrical installation does not conform to the regulations, the public utility or the inspector shall give the consumer notice in writing of its or his findings and may include in the notice an order directing the consumer to cause the electrical installation to conform to the regulations within a reasonable period of time to be stated in the notice.

- Where the consumer fails to cause the electrical installation to conform to the regulations within the period of time stated in the notice, the public utility shall, unless the period of time is extended by the Chief Inspector, disconnect or discontinue the supply of electrical energy or power to the electrical installation until the electrical installation is made to conform to the regulations.

- Where the period of time stated in the notice is extended by the Chief Inspector and the consumer fails to cause the electrical installation to conform to the regulations within the extended period of time, the public utility shall disconnect or discontinue the supply of electrical energy or power to the electrical installation until the electrical installation is made to conform to the regulations.

- Every contractor, before making any alterations or additions to an electrical installation, shall notify an inspector or the public utility supplying electrical power or energy to the electrical installation that such alterations or additions will be made, giving the date when the alterations or additions will be commenced.

- Every consumer or contractor shall give every inspector and public utility or its agent such access at all reasonable times to the premises of the consumer or contractor as may be necessary for the purpose of inspecting electrical installations and alterations and additions. No electrical installation nor any alteration or addition to an electrical installation shall be made except in conformity with this Act and the regulations.

- Where under this Act a duty is imposed upon a public utility to inspect an electrical installation or an alteration or addition to an electrical installation, the inspection shall be carried out by a person approved by the Fire Marshal for that purpose

- Every public utility, consumer, contractor or other person who violates or fails to observe any provision of this Act or the regulations is guilty of an offence and on summary conviction is liable to some specific penalty.

1.5 Summary

This chapter talks about briefly about the concept of installation & also it gives some basic, in other words to say some general laws and regulations which generally are present in all around the globe & they should be imposed & inspected by the electrical companies of that country.

2- INSTALLATION FUNDAMENTALS

2.1 Overview

This chapter includes the basic electrical components that are used commonly in installation projects like wiring, cables, fuses and installation accessories like switches, sockets, circuit breakers and etc and also it includes Brief Introduction of transmission and distribution of electricity.

2.2 Wiring

Electrical wiring is the fundamental of installation. In general it refers to insulated conductors used to carry electricity, and associated devices. This article describes general aspects of electrical wiring as used to provide power in buildings and structures, commonly referred to as building wiring.

2.2.1 Wiring safety codes

Electrical codes arose in the 1880s with the early commercial introduction of electrical power. Many conflicting standards existed for the selection of wire sizes and other design rules for electrical installations. The intention of wiring safety codes is to provide safeguarding of persons and property from hazards arising from the use of Regulations may be set by local city, provincial/state or national legislation, perhaps by amendments to a model code produced by a technical standards-setting organization, or by a national standard electrical code.

The first electrical codes in the United States originated in New York in 1881 to regulate installations of electric lighting. Since 1897 the U.S. National Fire Protection

Association, a private nonprofit association formed by insurance companies, publishes the National Electrical Code (NEC). States, counties or cities often include the NEC in their local building codes by reference along with local differences. The NEC is modified every three years.

Since 1927, the Canadian Standards Association has produced the Canadian Safety Standard for Electrical Installations, which is the basis for provincial electrical codes.

Although these two national standards deal with the same physical phenomena and broadly similar objectives, they differ occasionally in technical detail. As part of the NAFTA program, US and Canadian standards are slowly converging towards each other, in a process known as harmonization.

In European countries, an attempt has been made to harmonize national wiring standards in an IEC (international electro technical commission) standard, IEC 60364 Electrical Installations for Buildings. However, this standard is not written in such language that it can readily be adapted as a national wiring code. Neither is it designed for field use by electrical tradesmen and inspectors for acceptance of compliance to national wiring standards.

DKE - German Commission for Electrical, Electronic & Information Technologies of DIN and VDE - is the German organization responsible for the elaboration of electrical standards and safety specifications.

In the United Kingdom wiring installations are regulated by the produced by the IEE Requirements for Electrical Installations: IEE Wiring Regulations, BS 7671: 2001 which is now in its 16th edition. The first edition was published in 1882.

2.2.2 Wiring methods

Materials for wiring interior electrical systems in buildings vary depending on:

- Intended use and amount of power needed of the circuit.
- Type of occupancy and size of the building.
- National and local regulations.
- Environment in which the wiring must operate.

Wiring systems in a single family home or duplex, for example, are simple, with relatively low power requirements, infrequent changes to the building structure and layout, usually with dry, moderate temperature, and noncorrosive environmental conditions. In a light commercial environment, more frequent wiring changes can be expected, large apparatus may be installed, and special conditions of heat or moisture may apply. Heavy industries have more demanding wiring requirements, such as very large currents and higher voltages, frequent changes of equipment layout, corrosive, or wet or explosive atmospheres.

2.2.2.1 Early wiring methods

The very first interior power wiring systems used conductors that were bare or covered with cloth, which were secured by staples to the framing of the building or on running boards. Where conductors went through walls, they were protected with cloth tape. Splices were done similarly to telegraph connections, and soldered for security. Underground conductors were insulated with wrappings of cloth tape soaked in pitch, and laid in wooden troughs which were then buried. Such wiring systems were unsatisfactory due to the danger of electrocution and fire, and due to the high labor cost for installation. The earliest standardized method of wiring in buildings, in common use from about 1880 to the 1930s, was knob and tube (K&T) wiring: single conductors ran through cavities between the structural members in walls and ceilings, with ceramic tubes forming protective channels through joists and ceramic knobs attached to the structural members to provide air between the wire and the lumber, and to support the wires. Wiring in air has good capacity -- commonly, one wire size smaller than that needed in cables! Most circuits were for 120 volt usage, so one wire was on one side of a timber, the second on the other side. Such prevented driving a nail into both.

2.2.2.2 Other historical wiring methods

Other methods of securing wiring that are now obsolete include:

- Re-use of existing gas pipes for electric lighting. Insulated conductors were pulled into the pipes feeding gas lamps.
- Wood moldings with grooves cut for single conductor wires. These were eventually prohibited in North American electrical codes by the 1930s, but may still be permitted in other regions.
- Flexible cord stapled to the wall with appropriate surface-mount sockets and switches. This method is still commonly used to illegally add sockets to a room or even electrify an entire dwelling.

2.3 Cables

A cable is an assembly of two or more electrical conductors, usually held together with an overall sheath. The assembly is used for transmission of electrical power.

2.3.1 Power Cables

Modern cables come in a variety of sizes, materials, and types, each particularly adapted to its uses. Large single insulated conductors are also called power cables in the trade. The overall assembly may be round or flat. Filler strands may be added to the assembly to maintain its shape. Special purpose power cables for overhead or vertical use may have additional elements such as steel or Kevlar structural supports. Some power cables for outdoor overhead use may have no overall sheath. Other cables may have a plastic or metal sheath enclosing all the conductors. The materials for the sheath will be selected for the intended application, and may be especially resistant to water, oil, sunlight, underground conditions, chemical vapors, impact, or high temperatures. Cables intended for underground use or direct burial in earth will have heavy plastic sheaths, may be protected by a lead sheath, or may require special direct-buried construction. Where cables must run where exposed to impact damage, they are protected with flexible steel tape or wire armor, which may also be covered by a water resistant jacket.

2.3.2 Network Cabling

Network Cable is the medium through which information usually moves from one network device to another. There are several types of cable which are commonly used with LANs. In some cases, a network will utilize only one type of cable, other networks will use a variety of cable types. The type of cable chosen for a network is related to the network's topology, protocol, and size. Understanding the characteristics of different types of cable and how they relate to other aspects of a network is necessary for the development of a successful network.

2.3.3 Choosing the Correct size Cable

It is important to choose the correct size cable when connecting to the mains. The wire has to be the correct size so that it can cope with the power demands of the device. The size stated for cables is given in mm2 and this measurement is actually the cross sectional area of the wire inside.

The larger that area the higher the current it can carry. If a cable is used which is too small for the amount of current passing through, it becomes dangerous. This results in the wire overheating and causing a serious safety risk.

Table 2.1: Typical values of cable size available plus corresponding current rating and maximum power ratings.

Conductor Size	Current	Maximum power (Watts)
1.0 mm2	10 amps	Up to 2400 Watts
1.25 mm2	13 amps	Up to 3120 Watts
1.5 mm2	15 amps	Up to 3600 Watts
2.5 mm2	20 amps	Up to 4800 Watts
4.0 mm2	25 amps	Up to 6000 Watts

2.3.4 Basic Guidelines for Installing Cables

When running cable, it is best to follow a few simple rules:

- Always use more cable than you need. Leave plenty of slack.
- Test every part of a system as you install it. Even if it is brand new, it may have problems that will be difficult to isolate later.
- If it is necessary to run cable across the floor, cover the cable with cable protectors.
- Label both ends of each cable.
- Use cable ties (not tape) to keep cables in the same location together.

2.4 Cable Insulations

In the earlier times Insulation of cables were made of rubber. Rubber-insulated cables become brittle over time due to exposure to oxygen, so they must be handled with care, and should be replaced during renovations. When switches, outlets or light fixtures are replaced, the simple act of tightening connections may cause insulation to flake off the conductors. Rubber was hard to separate from bare copper, so copper was tinned.

From the late 1950s, PVC insulation and jackets were introduced, especially for house wiring. About the same time, single conductors with a thinner PVC insulation and a thin nylon jacket became common. Rubber-like synthetic polymer insulation is used in industrial cables and power cables installed underground because of its superior moisture resistance.

Insulated wires may be run in one of several forms of a raceway between electrical devices. This may be a pipe, called a conduit, or in one of several varieties of metal (rigid steel or aluminum) or non-metallic (PVC) tubing. Wires run underground, for example, may be run in plastic tubing encased in concrete, but metal elbows may be used in severe pulls. Wiring in exposed areas, for example factory floors, may be run in cable trays or rectangular raceways having lids. For protection from flame spread, fire stopping material, sometimes silicone, may be used. However, the thickness of such material along the cable must be held to a minimum, else this becomes a heat limit. Special fittings are used for wiring in potentially explosive atmospheres.

2.5 Cable Ratings

Cable jackets may be different materials to meet different UL ratings, but is generally rated for either normal in-wall installation or plenum installation. Commercial buildings usually use platinum-rated wire because at least some of their runs are through air platinum's (such as the space above suspended ceilings) associated with heating and cooling systems (HVAC). Building code usually requires platinum-rated wire in such ducts to ensure a fire is less likely to cause burning insulation to contaminate the air system. Platinum rated wire is jacketed in material like Teflon instead of the PVC usually used for non-plenum rated wire. Since homes seldom have duct systems where wire is run, PVC is usually acceptable, especially when put in walls. Therefore, all the audio/video cables discussed here are PVC, not platinum rated. Since platinum -rated cable is usually almost twice as expensive as PVC cable so mostly these days everywhere PVC cables are used.

There is an increasing move away from 70°C P.V.C. insulation to materials which are more environmentally friendly. The ratings of fuse gear, switches, accessories etc. are generally based upon the equipment being connected to conductors intended to be operated at a temperature not exceeding 70°C in normal service.

2.6 Electrical conductors

In science and engineering, conductors, such as an electrical connector, are materials that readily conduct electric current through electrical conduction. All conductors contain movable electric charges which will move when an electric potential difference (measured in volts) is applied across separate points on a wire (etc) made from the material. This flow of charge (measured in amperes) is what is meant by electric current. In most materials, the amount of current is proportional to the voltage (Ohm's Law) provided the temperature remains constant and the material remains in the same shape and state. The ratio between the voltage and the current is called the resistance (measured in ohms) of the object between the points where the voltage was applied. The resistance across a standard mass (and shape) of a material at a given temperature is called the resistivity of the material. The inverse of resistance and resistivity is conductance and conductivity.

Most familiar conductors are metallic. Coppers are the most common material for electrical wiring, and gold for high-quality surface-to-surface contacts. However, there are also many non-metallic conductors, including graphite, solutions of salts, and all plasmas. See electrical conduction for more information on the physical mechanism for charge flow in materials.

Aluminum is one of the most abundant of metals and constitutes about one-sixth of the earth's crust. For practical purposes it forms the only serious rival to copper as a conductor. For equal resistance it requires a croons-sectional area of 1.5 times that of copper in figure below, there is growing pressure to install aluminum conductor wherever possible, because of the increase in world copper prices.

Compared to copper, aluminum has worse conductivity per unit volume, but better conductivity per unit weight. In many cases, weight is more important than volume making aluminum the 'best' conductor material for certain applications. For example, it is commonly used for large-scale power distribution conductors such as overhead power lines. In many such cases, aluminum is used over a steel core that provides much greater tensile strength than would the aluminum alone.

The I.E.E. Regulations however do not permit the use of aluminum conductors unless they are 16 mm² o5r above in cross-sectional area. Aluminum does not have the same tensile strength nor is it as easy to manipulate as copper; difficulties can arise when making terminal connections as a result of creep or flow of the aluminum conductor.

Table 2.2: Current - carrying capacities of typical copper and aluminum cables. PVC non - armored single conductors.

Nominal (mm²)	copper (A)	Aluminum (A)
16	74	60
25	97	78
35	119	96
50	145	120

2.7 Accessories used in Installation

The term accessories used here is for the basic installation components such as switches, ceiling roses, lamp holders and socket outlets.

2.7.1 Fuses

In electronics and electrical engineering a **fuse**, short for 'fusible link', is a type of over current protection device (OCPD). It has as its critical component: a metal wire or strip that will melt when heated by a prescribed electric current, opening the circuit of which it is a part, and so protecting the circuit from an over current condition.

Properly-selected fuses (or other over current devices) are an essential part of a power distribution system to prevent fire or damage due to overload or short-circuits. Usually the maximum size of the over current device for a circuit is regulated by law. Local authorities will incorporate these national codes as part of law. An over current device should normally be selected with a rating just over the normal operating current of the downstream wiring or equipment which it is to protect.

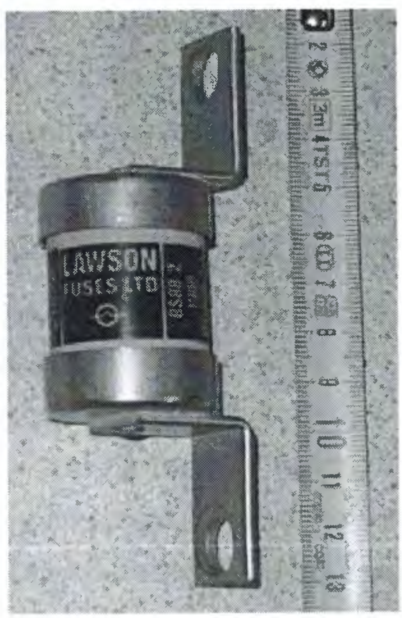


Figure 2.1: 200A Industrial fuse with 80kA breaking capacity.

2.7.1.1 Fuse characteristics

Each type of fuse (and all other over current devices) has a time-current characteristic which shows the time required melting the fuse and the time required to clear the circuit for any given level of overload current. Where the fuses in a system are of similar types, simple ratios between ratings of the fuse closest to the load and the next fuse towards the source can be used, so that only the affected circuit is interrupted after a fault. In power system design, main and branch circuit over current devices can be coordinated for best protection by plotting the time-current characteristics on a consistent scale, making sure that the source curve never crosses that of any of the branch circuits. To prevent damage to utilization devices, both "maximum clearing" and "minimum melting" fuse curves are plotted.

Fuses are often characterized as "fast-blow" or "slow-blow" | "time-delay", according to the time they take to respond to an over current condition. Fast-blow fuses (sometimes marked 'F') open quickly when the rated current is reached. Ultrafast fuses (marked 'FF') are used to protect semiconductor devices that can tolerate only very short-lived over currents. Slow-blow fuses (household plug types are often marked 'T') can tolerate a transient over current condition (such as the high starting current of an electric motor), but will open if the over current condition is sustained.

A fuse also has a rated interrupting capacity, also called breaking capacity, which is the maximum current the fuse can safely interrupt. Generally this should be higher than the maximum prospective short circuit current though it may be lower if another fuse or breaker upstream can be relied upon to take out extremely high current shorts. Miniature fuses may have an interrupting rating only 10 times their rated current. Fuses for low-voltage power systems are commonly rated to interrupt 10,000 amperes, which is a minimum capacity regulated by the electrical code in some jurisdictions. Fuses for larger power systems must have higher interrupting ratings, with some low-voltage current-limiting "high rupturing capacity" (HRC) fuses rated for 300,000 amperes. Fuses for high-voltage equipment, up to 115,000 volts, are rated by the total apparent power (megavolt amperes, MVA) of the fault level on the circuit.

Over current devices installed inside of enclosures are "de rated" at least per the US NEC. This is a hold-over from the first mounting of electrical devices on the surface of slate slabs. The slate was the insulating material between devices mounted in air. So, rather than change the fuse rating, it became common to allow only 80% of the current value of the over current device when the circuit is in operation for 3 hours or more (continuous loading).

As well as a current rating, fuses also carry a voltage rating indicating the maximum circuit voltage in which the fuse can be used. For example, glass tube fuses rated 32 volts should never be used in line-operated (mains-operated) equipment even if the fuse physically can fit the fuse holder. Fuses with ceramic cases have higher voltage ratings. Fuses carrying a 250 V rating can be safely used in a 125 V circuit, but the reverse is not true as the fuse may not be capable of safely interrupting the arc in a circuit of a higher voltage.

2.7.1.2 Fuse Boxes

Old electrical consumer units (also called fuse boxes) were fitted with fuse wire that could be replaced from a supply of spare wire that was wound on a piece of cardboard. Modern consumer units contain magnetic circuit breakers instead of fuses. Cartridge fuses were also used in consumer units and sometimes still are, as miniature circuit breakers (MCBs) are rather prone to nuisance tripping. (In North America, fuse wire was never used in this way, although so-called "renewable" fuses were made that allowed replacement of the fuse link. It was impossible to prevent putting a higher-rated or double links into the holder ("over fusing") and so this type must be replaced.)

Figure 2.2: A Typical Fuse Box.

The box pictured is a "Wylex standard". This type was very popular in the United Kingdom up until recently when the wiring regulations started demanding Residual-Current Devices (RCDs) for sockets that could feasibly supply equipment outside the equipotential zone. The design does not allow for fitting of RCDs (there were a few wylex standard models made with an RCD instead of the main switch but that isn't generally considered acceptable nowadays either because it means you lose lighting in the event of almost any fault) or residual-current circuit breakers with overload (RCBOs) (an RCBO is the combination of an RCD and an MCB in a single unit). The one pictured is fitted with rewirable fuses but they can also be fitted with cartridge fuses and MCBs. There are two styles of fuse base that can be screwed into these units—one designed for the rewirable fuse wire carriers and one designed for cartridge fuse carriers. Over the years MCBs have been made for both styles of base.

With both styles of base higher rated carriers had wider pins so a carrier couldn't be changed for a higher rated one without also changing the base. Of course with rewirable carriers a user could just fit fatter fuse wire or even a totally different type of wire object (hairpins, paper clips, nails etc.) to the existing carrier.

In North America, fuse boxes were also often used, especially in homes wired before about 1950. Fuses for these panels were screw-in "plug" type (not to be confused with what the British refer to as plug fuses), in holders with the same threads as Edison-base incandescent lamps, with ratings of 5, 10, 15, 20, 25, and 30 amperes. To prevent installation of fuses with too high a current rating for the circuit, later fuse boxes included rejection features in the fuse holder socket. Some installations have resettable miniature thermal circuit breakers which screw into the fuse socket. One form of abuse of the fuse box was to put a penny in the socket, which defeated the over current protection function and resulted in a dangerous condition. Plug fuses are no longer used for branch circuit protection in new residential or industrial construction.

2.7.1.3 Comparison of Fuses with Circuit Breakers

Fuses have the advantages of often being less costly and simpler than a circuit breaker for similar ratings. The blown fuse must be replaced with a new device which is less convenient than simply resetting a breaker and therefore likely to discourage people from ignoring faults. On the other hand replacing a fuse without isolating the circuit first (most building wiring designs do not provide individual isolation switches for each fuse) can be dangerous in itself, particularly if the fault is a short circuit.

High rupturing capacity fuses can be rated to safely interrupt up to 300,000 amperes at 600 V AC. Special current-limiting fuses are applied ahead of some molded-case breakers to protect the breakers in low-voltage power circuits with high short-circuit levels.

"Current-limiting" fuses operate so quickly that they limit the total "let-through" energy that passes into the circuit, helping to protect downstream equipment from damage. These fuses clear the fault in less than one cycle of the AC power frequency. Circuit breakers cannot offer similar rapid protection.

Circuit breakers which have interrupted a severe fault should be removed from service and inspected and replaced if damaged.

Circuit Breakers must be maintained on an annual basis to ensure their mechanical operation will not impede their performance during an interruption. For example, your household circuit breakers should be switched to the off position and back to the on position at least once per year, to "exercise" the circuit breakers. Failure to do so could result in the circuit breaker's failure to open when an over current is present. This is not the case with fuses, in which no mechanical operation is required for the fuse to operate under fault conditions.

In a multi-phase power circuit, if only one of the fuses opens, the remaining phases will have higher than normal currents, and unbalanced voltages, with possible damage to the coils of motors or solenoids. Fuses only sense over current, or to a degree, over-temperature, and cannot usually be used independently with protective relaying to provide more advanced protective functions, for example, ground fault detection. However, ground fault protection and other features provided by a circuit breaker can be provided by a bolted pressure switch that employs the use of fuses.

2.7.2 Circuit Breakers

A **circuit breaker** is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city. Switching device designed to protect an electric circuit from overloads such as excessive current flows and voltage failures. It has the same action as a fuse, and many houses now have a circuit breaker between the incoming mains supply and the domestic circuits

Figure 2.3: A 2 pole miniature circuit breaker.

Circuit breaker is an electric device that, like a fuse, interrupts an electric current in a circuit when the current becomes too high. The advantage of a circuit breaker is that it can be reset after it has been tripped; a fuse must be replaced after it has been used once. When a current supplies enough energy to operate a trigger device in a breaker, a pair of contacts conducting the current is separated by preloaded springs or some similar mechanism. Generally, a circuit breaker registers the current either by the current's heating effect or by the magnetism it creates in passing through a small coil. Because it is usual for an electric arc to form between the contacts when a breaker opens, some means must be provided for preventing rapid erosion of the contacts. Normally this is done by opening the contacts fast enough to make the arc of short duration.

2.7.2.1 Components of Circuit Breakers

Circuit breakers have five main components, as shown in figure 2.4. The components are the frame, the operating mechanism, the arc extinguishers and contacts, the terminal connectors, and the trip elements.

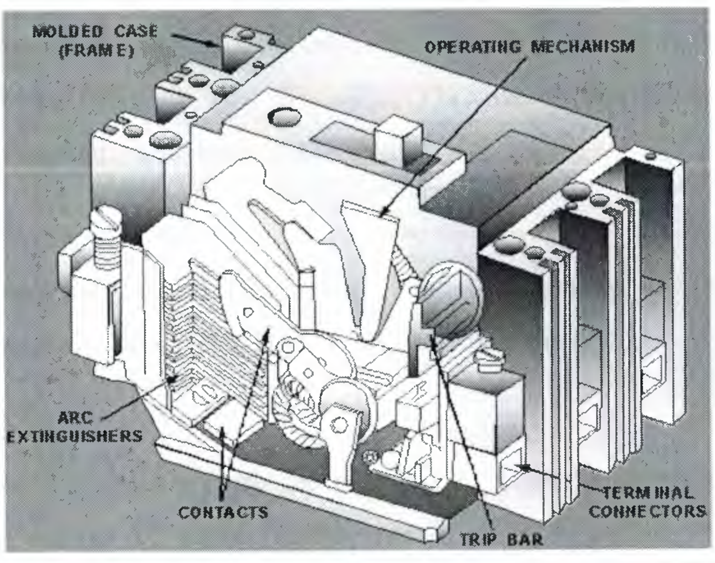


Figure 2.4: Circuit breaker components.

The FRAME provides an insulated housing and is used to mount the circuit breaker components (fig. 2.4). The frame determines the physical size of the circuit breaker and the maximum allowable voltage and current.

The OPERATING MECHANISM provides a means of opening and closing the breaker contacts (turning, the circuit ON and OFF). The toggle mechanism shown in figure 2.4 is the quick-make, quick-break type, which means the contacts snap open or closed quickly, regardless of how fast the handle is moved. In addition to indicating whether the breaker is ON or OFF, the operating mechanism handle indicates when the breaker has opened automatically (tripped) by moving to a position between ON and OFF. To reset the circuit breaker, the handle must first be moved to the OFF position, and then to the ON position.

2.7.2.2 Types of Circuit Breakers

There are many different technologies used in circuit breakers and they do not always fall into distinct categories. Types that are common in domestic, commercial and light industrial applications at low voltage (less than 1000 V) include:

- MCB (Miniature Circuit Breaker) rated current not more than 100 A, trip characteristics normally not adjustable. Thermal or thermal-magnetic operation. Breakers illustrated above are in this category.

- MCCB (Molded Case Circuit Breaker) rated current up to 1000 A. Thermal or thermal-magnetic operation. Trip current may be adjustable.

Electric power systems require the breaking of higher currents at higher voltages. Examples of high-voltage AC circuit breakers are:

- Vacuum circuit breaker with rated current up to 3000 A, these breakers interrupts the current by creating and extinguishing the arc in a vacuum container. These can only be practically applied for voltages up to about 35,000 V, which corresponds roughly to the medium-voltage range of power systems. Vacuum circuit breakers tend to have longer life expectancies between overhaul than do air circuit breakers.

- Air circuit breaker—rated current up to 10,000 A. Trip characteristics are often fully adjustable including configurable trip thresholds and delays. Usually electronically controlled, though some models are microprocessor controlled via an integral electronic trip unit. Often used for main power distribution in large industrial plant, where the breakers are arranged in draw-out enclosures for ease of maintenance.

Figure 2.5: Front panel of a 1250 A air circuit breaker.

2.7.2.3 Installation of Circuit Breakers

Installing a basic single-pole circuit breaker involves 5 steps:

- First: Turn Off The Power.
- Feed the cable into the breaker panel.
- Connect the ground wire.

- Connect the neutral wire.
- Connect the hot wire to the breaker and snap it in place.

2.7.2.4 Advantages of using Circuit Breakers

The circuit breaker is an absolutely essential device in the modern world, and one of the most important safety mechanisms in your home. Whenever electrical wiring in a building has too much current flowing through it, these simple machines cut the power until somebody can fix the problem. Without circuit breakers (or the alternative, fuses), household electricity would be impractical because of the potential for fires and other mayhem resulting from simple wiring problems and equipment failures.

When a current exceeds a fixed limit as it flows through the magnetic coil of a circuit breaker, a triggering mechanism is released, pulling the contacts apart and opening the circuit, thus preventing any more current flowing. Circuit breakers have many advantages; for example, they are fast acting, can be adjusted to operate at different current values, and can be easily reset.

2.7.3 Switches

A switch is a device for changing the course (or flow) of a circuit. The term "switch" typically refers to electrical power or electronic telecommunication circuits. In applications where multiple switching options are required (e.g., a telephone service), mechanical switches have long been replaced by electronic variants which can be intelligently controlled and automated.

In the simplest case, a switch has two pieces of metal called contacts that touch to make a circuit, and separate to break the circuit. The contact material is chosen for its resistance to corrosion, because most metals form insulating oxides that would prevent the switch from working. Contact materials are also chosen on the basis of electrical conductivity, hardness (resistance to abrasive wear), and mechanical strength, low cost and low toxicity.

Sometimes the contacts are plated with noble metals. They may be designed to wipe against each other to clean off any contamination. Nonmetallic conductors, such as conductive plastic, are sometimes used.

Multi way switching is a method of connecting switches in groups so that any switch can be used to connect or disconnect the load. This is most commonly done with lighting.

First method:

- double wire between both switches
- single wire from one switch to the mains
- single wire from the other switch to the load
- single wire from the load to the mains

Second method:

- triple wire between both switches
- single wire from any position between the two switches, to the mains
- single wire from any position between the two switches, to the load
- single wire from the load to the mains

5 A switches may be obtained in the form of 1. Way, 2 ways, intermediate or double pole and dimmer control. Alternative methods of switch operation are dolly, rocker, and cord, pushbutton or key. In all cases an earth terminal connected to an appropriate circuit protective conductor is necessary.

Double-pole switches are available with dimensions similar to the 1-way switches, and a neon lamp may be fitted to them as part of a single assembly. Indicator lights are desirable as pilot lamps for no luminous heating or other appliances. Where it is possible to touch the heating elements of radiators, double-pole control must be fitted.

2.7.3.1 Main Switch

The main switch allows you to turn off the electricity supply to the electrical installation. Note that some electrical installations may have more than one main switch.

For example, if your house is heated by electric storage heaters, you will probably have a separate main switch and consumer unit arranged to supply them.

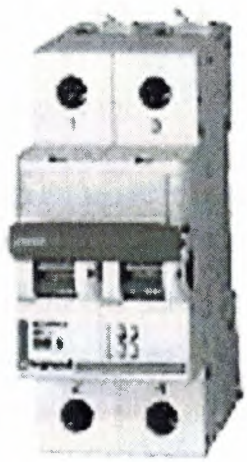


Figure 2.6: A typical Main switch.

It is important to know where the consumer unit is located and that it is accessible. It is also important that you know where the main switch are in order to turn it (them) off in the event of an emergency.

2.7.4 Grounding

The basic idea of an electrical safety earth (or ground) is pretty much the same everywhere. The case (chassis) of the equipment (and except for special situations, the internal electronics) is connected to an earth pin on the mains outlet. This is then connected through the house wiring and switchboard to an electrically solid earth point, which is commonly a (copper) water pipe, or a stake buried deep into the ground.

Should a fault develop within the equipment that causes the active (live) conductor to come into contact with the chassis, the fault current will flow to earth, and the equipment or main switchboard fuse or circuit breaker will blow. This protects the user from electric shock, bypassing the dangerous current directly to earth

The earth is made up of materials that are electrically conductive. A fault current will flow to 'earth' through the live conductor, provided it is earthed. This is to prevent a potentially live conductor from rising above the safe level. All exposed metal parts of an electrical installation or electrical appliance must be earthed.

The main objectives of the grounding are to:

- Provide an alternative path for the fault current to flow so that it will not endanger the user
- Ensure that all exposed conductive parts do not reach a dangerous potential
- Maintain the voltage at any part of an electrical system at a known value so as to prevent over current or excessive voltage on the appliances or equipment.

The qualities of a good earthing system are:

- Must be of low electrical resistance.
- Must be of good corrosion resistance.
- Must be able to dissipate high fault current repeatedly.

In electrical circuits the term ground or earth usually means a common return path. The terms Earth return and ground returns are also common.

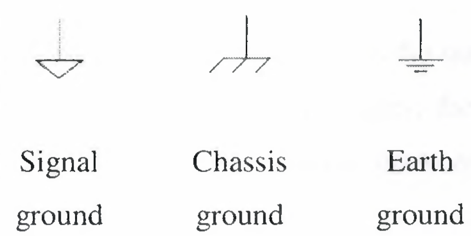


Figure 2.7: General Ground symbols.

In wiring installation, the ground is a wire with an electrical connection to earth, that provides an alternative path to the ground for heavy currents that might otherwise flow through a victim of electric shock. This power ground grounding wire is (directly or indirectly) connected to one or more earth electrodes. These may be located locally, be far away in the suppliers network or in many cases both. This grounding wire is usually but not always connected to the neutral wire at some point and they may even share a cable for part of the system under some conditions. The ground wire is also usually bonded to pipe work to keep it at the same potential as the electrical ground during a fault. Water supply pipes often used to be used as ground electrodes but this was banned in some countries when plastic pipe such as PVC became popular. This type of ground applies to radio antennas and to lightning protection system.

2.7.5 Socket outlets

The accessory may be of the switched or un switched version provided the supply is a. c Domestic ratings are 2,5,13 and 15 A; where required for industrial establishments, the range is extended to 16,30,32,63 and 125 A.

Utmost care must be taken in making connections so that the switch of switch-socket outlets is connected to the live conductor. Any extended use of flexible cord connectors is to be deprecated. Where fitted they should be of the non-reversible type so as to retain the correct connections for switches and thermostats.

All socket outlets in one room must be connected to the same phase. Where it may not be possible to fulfill this condition in industrial premises, then the socket outlet on one phase is to be grouped together. The minimum distance between socket outlets on different phases should be 2 m.

2.7.6 Ceiling roses

Modern ceiling roses are usually made from Bakelite and have four terminals. In addition to the flexible cord connections one phase terminal (with a protective insulating cover) loop-in purposes and the remaining terminal is for connection to the circuit protective conductor. To comply with the I.E.E. Regulations, connections to the terminals must be enclosed a patters or box. Unless specially designed for multiple cord only one flexible cord outlet is permitted.

2.7 Generation, Transmission & Distribution

- Generation

Electricity is produced, or generated, by the turning of turbines. In most power plants, these turbines are turned by pressurized steam. The steam is created by the burning of coal or other fossil fuels in massive boilers. In the case of hydroelectricity, the force of rushing water turns the turbines.

- Transmission

Once the turbines generate the electricity, its voltage is significantly increased by passing it through step-up transformers. Then the electricity is routed onto a network of high-voltage transmission lines capable of efficiently transporting electricity over long distances.

- Distribution

At the electric distribution substation that serves your home, the electricity is removed from the transmission system and passed through step-down transformers that lower the voltage. The electricity is then transferred onto your local electric co-op's network of distribution lines and delivered to your home. There, the electricity's voltage is lowered again by a distribution transformer and passed through your electric meter into your home's network of electric wires and outlets.

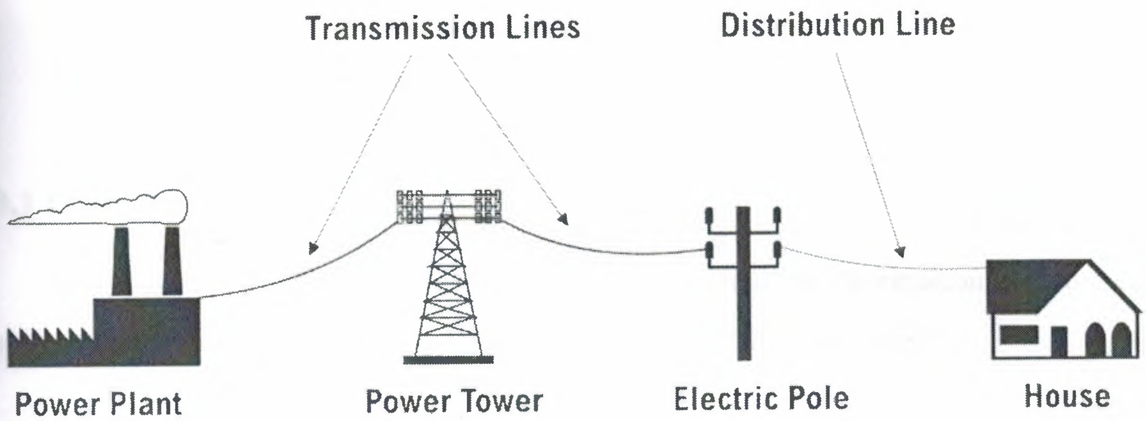


Figure2.8: Shows the transportation of electricity from the power plant until it reaches the consumers home.

2.9 Summary

In this chapter I presented some main components of installation like wiring, cables and the different accessories used in installation, some installation techniques and brief explanation of the steps describing how Electricity reaches our homes & Industries.

3- ILLUMINATION SYSTEM

3.1 Overview

This chapter includes a fully detailed explanation about the illumination components such as Lamps & their types, Lamp holders, dimmers & lamp Maintenance.

3.2 What is light?

Light is a radiant energy, which is propagated in the form of electromagnetic waves at the velocity of approximately $3x10^8$ m/s. the electromagnetic waves act upon the retina of the eye thus stimulating the optic nerves to produce the sensation of light. The impression of color depends upon the wavelength falling on the retina of the eye.

The importance of electric lighting in modern life is becoming increasingly appreciated. Bad lighting may not only bring a feeling of discomfort and fatigue but has also been the cause of many accidents. On the other hand, good lighting helps towards providing pleasant surroundings and makes a definite contribution towards safety.

Whatever the light is suitable for a particular situation depends upon many factors; these include quantity and quality of the light, color, contrast and direction.

3.2.1 Effect of Glare on eye

If intensive brightness is produced, Rays from this bright source, in addition to those from reflective surfaces, could damage the sensitive retina of the eye.

To minimize these harmful effects, the iris acts as a shutter and operates so as to reduce the amount of light entering the eye. Thus a bright light under these circumstances actually hinders instead of improving vision.

3.3 Lightning of Houses

We all need some form of artificial lighting around our homes, but what type and where?

Lighting can be separated into three basic groups:

General lighting - the lamps which give the ambient light in an area, often a replacement for natural sunlight.

Task lighting - used to illuminate an area for a particular task - cooking, reading etc. When not required for the task, the lamp is normally switched off.

Accent lighting - the lighting for decorative purposes - to display a particular feature or item - ceiling beams or a picture on the wall.

- General Lighting

General lighting is often provided by traditional pendant types, down lights, chandeliers, or ceiling mounted fixtures etc. The decor and aspect of the room will affect the amount of general lighting required.

- Task Lighting

Task lighting is often provided by portable standard lamps, wall mounted spot lights, desk mounted lamps, standard lamps, or above worktops fixed lights.

- Accent Lighting

Accent lighting is often provided by wall or ceiling mounted spot lights, or wall mounted coving lights.

Lighting was one the first application of electricity and still remains of very great importance, and the basic components of obtaining light are lamps.

3.4 Types of Lamps

The widespread use of electric lighting began with the invention of the first practical incandescent lamp by Thomas Edison and Joseph Swan in the nineteenth century. Since then there have been significant improvements in lamp efficiency as well as the different types of lamp.

As discussed in the overview, light sources used today in architectural lighting can be divided into two main categories: incandescent and luminescent gaseous discharge lamps. The gaseous discharge type of lamp is either low or high pressure. Low-pressure gaseous discharge sources are the fluorescent and low-pressure sodium lamps. Mercury vapor, metal halide and high-pressure sodium lamps are considered high-pressure gaseous discharge sources.

These are the most common light sources used in the field architectural lighting. Each light source will be described in terms of its three primary components: (1) light-producing element (lamp), (2) enclosure (luminary), and (3) electrical connection.

3.4.1 Incandescent Lamps

Incandescent lamps generate light by passing an electric current through a thin, filament wire until the wire is white-hot. They are used mainly in residential applications because they emit a "warmer" light that contains less red and blue. Incandescent lamps include enclosures (bulbs) made from a ribbon of hot glass that is first thickened and then blown into molds. These glass enclosures are then cooled, cut from the ribbon, and coated with a finishing material. The filament is formed by drawing tungsten metal into a tightly coiled wire. The finished filament is then clamped or welded to leads which are embedded in a glass supporting structure. This structure is then inserted into the bulb and the parts are fused together. When most of the oxygen has been removed, the bulb opening is sealed and a base is attached.

In broad terms, incandescent lamps are cheap to install but expensive to run. They can be justified if initial costs must be kept to a minimum and the annual hours of use are small or they are to be used intermittently with frequent switching. In some cases, the effects required in display or prestige interiors may warrant the use of small incandescent sources due to the precise control possible; however they should not normally be used for the general lighting of interiors.

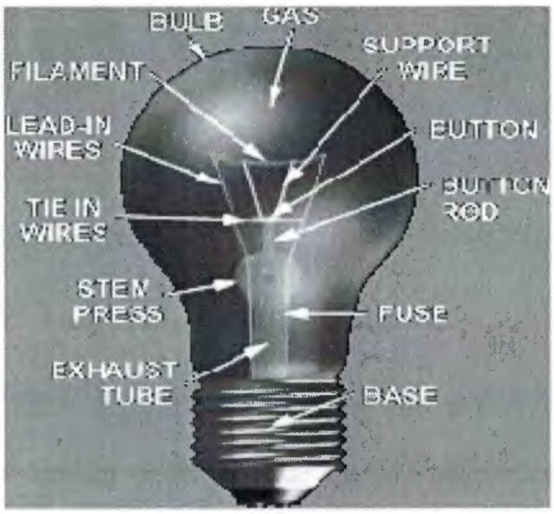


Figure 3.1: Features typical of an incandescent light globe.

3.4.1.1 Typical features of an Incandescent light Globe

Light is produced in an incandescent lamp by heating a thin metal wire to very high temperatures (around 2200°C), causing it to incandesce or glow. The wire is called a filament and the incandescence is a result of the filament's resistance to the flow of electrical current. Filaments are almost universally made from Tungsten as no other substance is as efficient in converting electrical energy into light on the basis of life and cost. Tungsten has four important characteristics in this regard: a high melting point, low evaporation, high strength yet reasonably ductile, and it has desirable radiation characteristics. The most common filament letter designations are straight (s), coiled (c), coiled coil (cc) and ribbon or flat (r). Coiled coil filaments are the most efficient and widely used filament type.

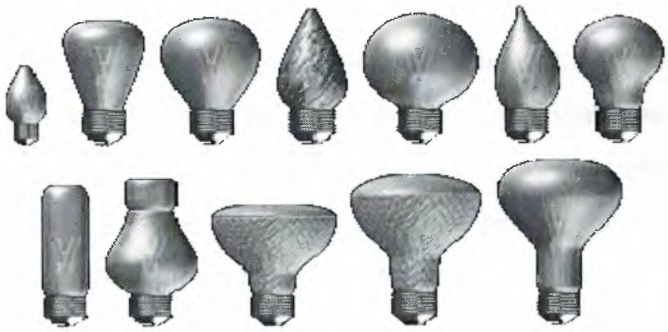


Figure 3.2: Different shapes and types of incandescent bulb.

There are a number of types of bulb color coating in use:

- Sprayed lacquers applied to the outside of the bulb are highly transparent (more efficient) but easily scratched or scuffed.
- Plastic coatings are slightly less transparent but have a high resistance to abrasion and weathering.
- Transparent ceramic enamels are fused to the bulb by heat. They are not as transparent as either the sprayed lacquers or plastic coating but are significantly more durable.
- Dichroic filters are created by applying several thin coats of metallic film to the face of the lamp. Because the film passes only wavelengths in small color bands and reflects all others internally, the effect is slightly more efficient than passing the light through a conventional color-absorbing material, and produces what some experts describe as a more brilliant light.

▪ Bulb silvering can also be considered a lamp coating. This involved coating a part of the lamp with aluminum to act as a reflector. This can be done behind the lamp to increase its downward efficiency or in front for use in up lighting installations.

The base provides the electrical connection to the filament. Some bases are also used to position or align the filament in an optical system. There are eight types of bases: (1) screw, (2) screw with ring contacts (three-way), (3) skirted screw, (4) bipost, (5) pre focus, (6) disc, (7) bayonet, and (8) prong. The most common base is the screw base around the world, however in Australia the bayonet is the most common in domestic applications.

No commonly used light source emits equal amounts of each light frequency, including daylight. Incandescent lamps are known for their warm color, resulting from the fact that they emit lower frequency red and orange light than high frequency blue and violet. The graph below clearly shows this bias towards the lower end of the visible spectrum.

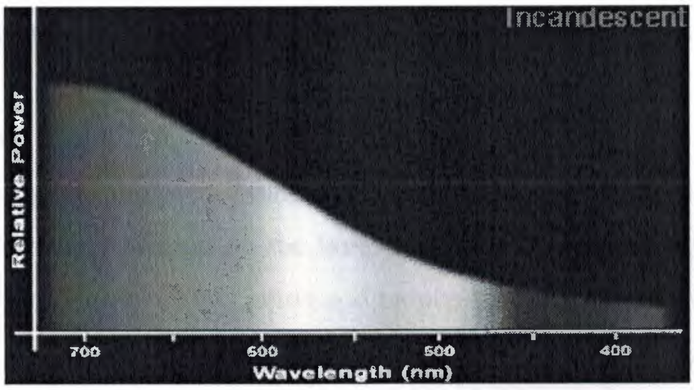
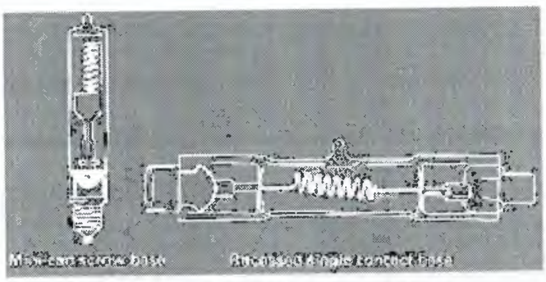


Figure 3.3: Spectral output of a typical incandescent bulb.

3.4.2 Tungsten Halogen Lamps

Some high intensity / long life globes are called tungsten halogen or quartz halogen. These lamps are filled with a halogen gas, usually bromide or iodine. The nature of this gas means that any tungsten atoms that evaporate from the surface of the filament combine chemically with surrounding iodine atoms. In this state, they cannot form a black coating on the inside of the bulb, moving around until they impact with the hot filament. When this happens, they split back into tungsten and iodine, depositing the tungsten atom back onto the filament and releasing the iodine atom to continue the cycle. This allows much higher operating temperatures which require special bulbs, usually made from quartz or fused silica.



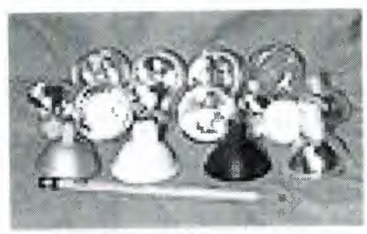


Figure 3.4: Structure of Tungsten-halogen lamps and its various types.

Tungsten-halogen lamps are dimmable. However, dimming will reduce the bulb temperature causing the tungsten-iodine cycle to stop, resulting in bulb wall blackening. Manufacturers claim that turning up the lamp to "full on" will clean the lamp. Extended dimming will increase lumen depreciation and reduce lamp life slightly.

Tungsten-halogen is an expensive incandescent lamp that has a very compact envelope which makes it an excellent lamp where optical control is important. It still has all of the negative aspects of the standard incandescent which are a relatively short life and a low efficacy which makes the tungsten-halogen expensive to operate and maintain. Color rendition, however, is excellent.

The normal voltage (120/240 V) lamp requires no auxiliary equipment (no ballast) which results in a slightly lower initial cost. The low voltage tungsten-halogen lamps require a step down transformer to reduce the line voltage from 120/240 V to 12 V. The transformer adds to the initial cost of the system and introduces a device that may require additional maintenance and has to be put somewhere.

The output spectrum of a tungsten halogen lamp is very similar to other incandescent lamps, shown above.

3.4.3 Fluorescent Lamps

The most common application of Electrical discharge lamps is in tubular fluorescent lamps. A range of different phosphor coatings are used to modify the output spectrum. The standard fluorescent tube has a diameter of 38mm and a length of 0.6, .9, 1.2, 1.5, 1.8 or 2.4 meters. More recently, such lamps are available in both circular form as well as compact fluorescents utilizing folded tubes of much smaller diameter.

There's more than a difference in appearance separating fluorescent and incandescent lamps. An incandescent bulb generates light through heat. When electrical current passes through the tungsten filament, it heats to the point where it glows and gives off a yellow-red light. To keep the filament from burning up immediately, it's housed in a vacuum. Even so, the intense heat of the filament ensures a comparatively short and expensive life span.

A fluorescent lamp has no filament running through it. Instead, cathodes (coiled tungsten filaments coated with an electron-emitting substance) at each end send current through mercury vapors sealed in the tube. Ultraviolet radiation is produced as electrons from the cathodes knock mercury electrons out of their natural orbit. Some of the displaced electrons settle back into orbit, throwing off the excess energy absorbed in the collision. Almost all of this energy is in the form of ultraviolet radiation.

To turn this radiation into visible light, the inside of the tube has a phosphor lining. The phosphors have the unique ability to lengthen UV wavelengths to a visible portion of the spectrum. Put another way, the phosphors are excited to fluorescence by bursts of UV energy.

The easiest fluorescent fixture to explain is a design offered by Sylvania in 1938. This early preheat model is no longer made, but millions are still in service, and its principle design features are found in every new fixture.

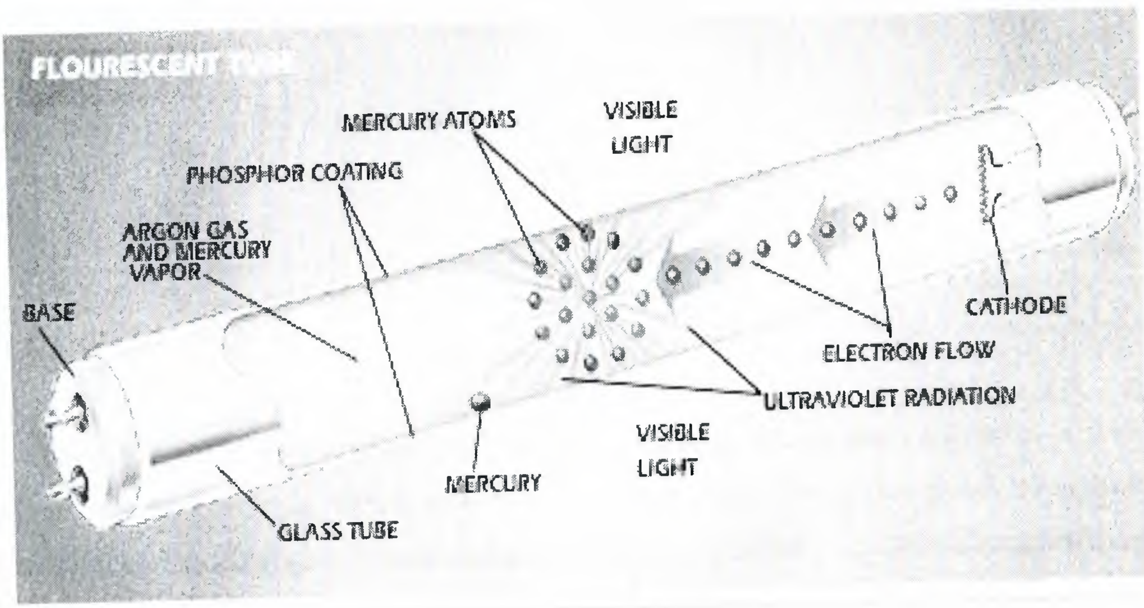


Figure 3.5: Typical fluorescent tube is filled with inert gas and a small amount of mercury that creates vapor.

Generating fluorescent light occurs in two stages. First, electrons emitted from cathodes create an electrical arc through mercury vapor. Then, resultant ultraviolet radiation strikes phosphor coating which then gives off visible light. Bi-pin bases are necessary for preheat and Rapid-Start fixture designs.

3.4.3.1 Preheat Fixtures

Original preheat circuit uses a starter. When starter switch is closed, current runs through and heats cathodes. When arc through tube is established, switch opens.

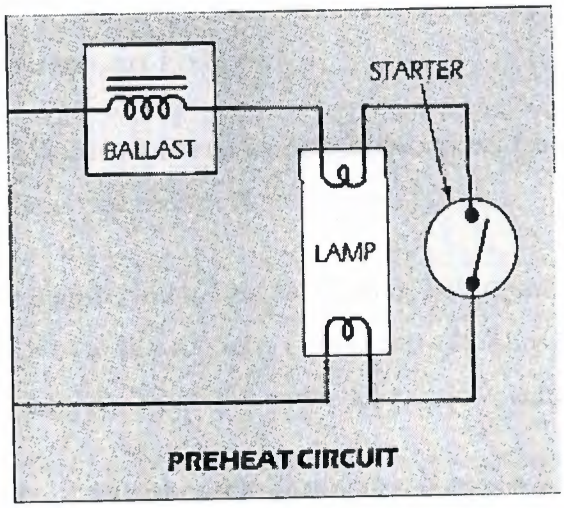


Figure 3.6: Preheat Circuit.

The heart of every fluorescent fixture is its ballast. The ballast consists of a wire winding on an iron core, which reduces and regulates the voltage that flows through it. Electrical current enters the fixture through the ballast. From there, it flows through wiring to lamp holders, and ultimately, to cathodes within the tube.

However, more power is required to start a fluorescent lamp than to maintain it. Preheat fixtures get their name from a starting circuit that sends increased current through the cathodes to heat their coated filaments. The heated cathodes send a high-voltage pulse along the tube that creates an arc through the mercury vapor. As the atmosphere inside the tube heats up, electron activity increases to its most efficient, ballast-sustained level, and the mercury vapor carries the current on its own. The starting circuit is controlled by a starter switch that opens after a short preheat period (see preheat starter circuit diagram).

A variation of the starter-switch concept can be found in small desk lamps. Here, however, the starter switch is manual you simply hold down the switch button until enough heat is generated to sustain the arc through the mercury vapor.

3.4.3.2 Instant-and Rapid-Start Fixtures

An Instant-Start fixture needs no starter switch. It uses special ballast that supplies enough energy to start and maintain the electrical arc through the tube.

Beyond the starter mechanism and a little fine-tuning, subsequent fluorescent fixtures have changed very little. Both the Instant-Start (1944) and the Rapid-Start (1952) versions are merely adjustments to improve reliability and reduce maintenance.

Instant-Start fixtures have ballasts with continuous output high enough to strike an arc instantly. Because no preheating occurs, Instant-Start tubes need only one pin at each end. While some Instant-Start tubes have bi-pin bases, the pins are joined at the base. In this case, they're merely structural and not electrical (see Instant-Start circuit diagram).

Modern Rapid-Start fixtures are also designed without starters, though they are true bi-pin/preheat fixtures. They have smaller, more efficient ballasts with built-in heating windings that preheat the cathodes for quick starts (see Rapid-Start circuit diagram).

3.4.3.3 Fluorescent Overview

Newer Rapid-Start fixture is similar to preheat type, but without starter. Ballast has separate winding that heats the cathodes to start the electrical arc.

Fluorescent tubes have several real advantages over incandescent lamps. They are a good deal more efficient, producing more light per watt of input than incandescent. While a standard incandescent bulb might last 1000 hours, a fluorescent lamp might last 9000, with

6000 to 7500 hours being average. In fact, the number of hours that a tube operates has less of an effect on tube life than the number of starts it endures.

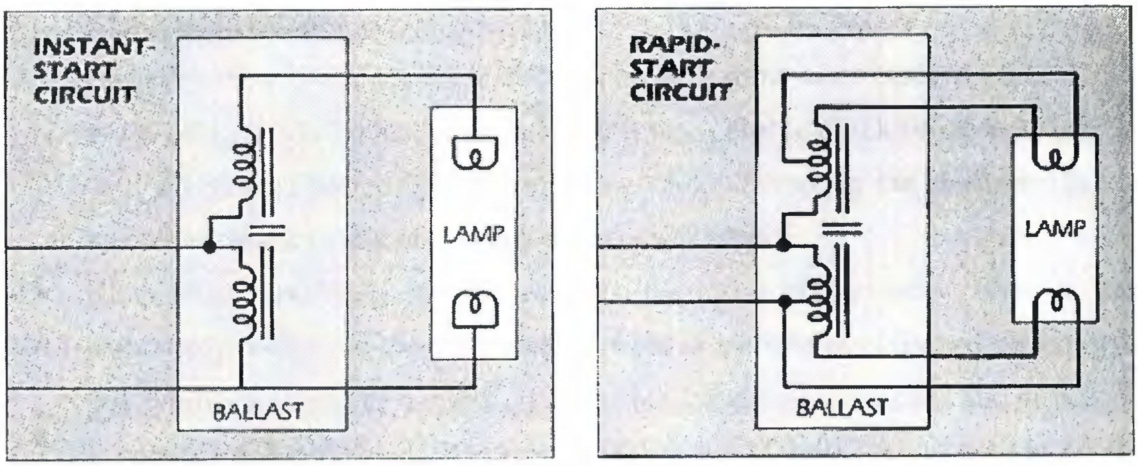


Figure 3.7: Instant and Rapid Start Circuits.

The greatest hesitation that most of us have about fluorescents is the ghoulish-green light given off by cool-white lamps. Warmer, more flattering lamps have been around for years, but they generally produce less light, and are more expensive to operate.

Recent advances have solved the color-versus-efficiency quandary. New rare-earth phosphors, applied in layers, now put warm-tone lighting in the high-efficiency category. You'll easily pay three to four times more for the tubes than for cool whites, but you'll also use less energy.

3.4.3.4 Safely Working with Fluorescent Lamps and Fixtures

There aren't many dangers associated with typical fluorescent lamps and fixtures:

- Electric shock: There is usually little need to probe a live fixture. Most problems can be identified by inspection or with an ohmmeter or continuity tester when unplugged.

- Fluorescent lamps and fixtures using iron ballasts are basically pretty inert when unplugged. Even if there are small capacitors inside the ballast(s) or for RFI prevention, these are not likely to bite. However, you do have to remember to unplug them before touching anything!
- However, those using electronic ballasts can have some nasty charged capacitors so avoid going inside the ballast module and it won't hurt to check between its outputs with a voltmeter before touching anything. Troubleshooting the electronic ballast module is similar to that of a switch mode power supply.
- Nasty chemicals: While the phosphors on the inside of fluorescent tubes are not particularly poisonous, there is a small amount of metallic mercury and contact with this substance should be avoided. If a tube breaks, clean up the mess and dispose of it properly and promptly. Of course, don't go out of your way to get cut on the broken glass!

3.4.3.5 Problems with Fluorescent Lamps and Fixtures

In addition to the usual defective or damaged plugs, broken wires in the cord, general bad connections, fluorescent lamps and fixtures have some unique problems of their own. The following assumes a lamp or fixture with conventional iron (non-electronic) ballast. Always try a new set of fluorescent tubes and starter (where used) before considering other possible failures. If two tubes dim or flicker in unison, this means that both are powered by the same ballast. Often this means that one tube has failed, although the other tube may also be in poor condition or approaching the end of its life. Both tubes must be replaced with known good tubes in order to rule out defective ballast.

- **Bad fluorescent tubes**. Unlike incandescent lamps where a visual examination of the bulb itself will often identify a broken filament, there is often no way of just looking at a fluorescent tube to determine if it is bad. It may look perfectly ok though burned out fluorescents will often have one or both ends blackened. However, a blackened end is not in itself always an indication of a bad tube. Blackened ends are a somewhat reliable means of identifying bad tubes in 34 or 40 watt rapid start fixtures. Blackened ends are not as reliable an indicator in preheat or trigger start fixtures, or for tubes of 20 watts or less.

Failure of the electrodes/filaments at one or both ends of the fluorescent tube will usually result in either a low intensity glow or flickering behavior, or sometimes in no light at all. A broken filament in a fluorescent tube used in a preheat type fixture (with a starter) will almost always result in a totally dead lamp as there will be no power to the starter. Dim glow is rare in this case and would probably be confined to the region of the broken filament if it occurs. The best approach is to simply try replacing any suspect tubes - preferably both in a pair that are driven from single ballast.

In fixtures where rapid start ballast runs two tubes, both tubes will go out when one fails. Sometimes one or both tubes will glow dimly and/or flicker. If one tube glows dimly and the other is completely dead, this does not indicate which tube has failed. The brighter tube may be the good one or the bad one. The bad tube usually has noticeable blackening at one end. It may pay to replace both tubes, especially if significant labor costs are involved. Also, prolonged dim-glowing may degrade the tube that did not initially fail.

In trigger start fixtures that use one ballast to power two 20 watt tubes, sometimes both tubes will blink or intermittently dim. Replacing either tube with a known good tube may fail to fix this. The tubes may continue blinking or intermittently dimming until both are replaced with brand new tubes. This sometimes indicates borderline low line voltage ("brownout", etc.), non ideal temperatures, or borderline (probably cheaply designed) ballast.

- **Bad starter (preheat fixtures only).** The little starter can may go bad or be damaged by faulty fluorescent tubes continuously trying to start unsuccessfully. It is a good idea to replace the starter whenever tubes are replaced in these types of fixtures. One way that starters go bad is to "get stuck". Symptoms of this are the ends of the affected tube glowing, usually with an orange color of some sort or another but sometimes with a color closer to the tube's normal color if arcs form across the filaments. Occasionally, only one end arcs and glows brightly, and the other end glows dimmer with a more orange color.

Should one or both ends glow with a bright yellowish orange color with no sign of any arc discharge surrounding each filament, then the emissive material on the filaments is probably depleted or defective. In such a case, the tube should be replaced regardless of what else is wrong. If both ends glow a dim orange color, then the filaments' emissive coating may or may not be in good shape. It takes approx. 10 volts to form an arc across a healthy fluorescent lamp filament.

- **Defective iron ballast**. The ballast may be obviously burned and smelly, overheated, or have a loud hum or buzz. Eventually, a thermal protector built into many types of ballast will open due to the overheating (though this will probably reset when it cools down). The fixture may appear to be dead. Bad ballast could conceivably damage other parts as well and blow the fluorescent tubes. If the high voltage windings of rapid start or trigger start ballasts are open or shorted, then the lamp will not start.

Ballasts for fixtures less than 30 watts usually do not have thermal protection and in rare cases catch fire if they overheat. Defective fixtures should not be left operating.

- **Bad sockets.** These can be damaged through forceful installation or removal of a fluorescent tube. With some ballasts (instant start, for example), a switch contact in the socket prevents generation of the starting voltage if there is no tube in place. This minimizes the possibility of shock while changing tubes but can also be an additional spot for a faulty connection.

- **Lack of ground**. For fluorescent fixtures using rapid start or instant start ballasts, it is often necessary for the metal reflector to be connected to the electrical system's safety ground. If this is not done, starting may be erratic or may require you to run your hand over the tube to get it to light. In addition, of course, it is an important safety requirement.

3.5 Lamp Holders

The most common is the cord-grip Bakelite bayonet cap (BC). Small bayonet cap holders (SBC) have a general use for decorative candle lamps. Both BC and Edison screw (ES) lamp holders are available for 100 W and 150 W lamps. Goliath Edison screw (GES) types are necessary for the higher wattages.

Screwed lamp holders require special care in ensuring that the threaded portion is connected to the neutral conductor. Brass lamp holders must be solidly bonded to earth. Certain holders have an important safety feature: a locking screw or similar device to prevent unscrewing of the top cover when taking off the shade ring, thus exposing the live terminals.

3.6 Dimmers

Dimmers are devices used to vary the brightness of a light. By decreasing or increasing the RMS voltage and hence the mean power to the lamp it is possible to vary the intensity of the light output. Although variable-voltage devices are used for various purposes, the term dimmer is generally reserved for those intended to control lighting.

Dimmers range in size from small units the size of a normal light switch used for domestic lighting to high power units used in large theatre or architectural lighting installations. Small domestic dimmers are generally directly controlled, although remote control systems are available. Modern professional dimmers are generally controlled by a digital control system.

In the professional lighting industry changes in intensity are called "fades" and can be "fades up" or "fades down". Dimmers with direct manual control had a limit on the speed they could be varied at but this issue is pretty much gone with modern digital units (although very fast changes in brightness may still be avoided for other reasons like bulb life).

They are used instead of variable resistors because they have higher efficiency. A variable resistor would dissipate power by heat (efficiency as low as 0.5). By switching on and off, theoretically a dimmer does not heat up (efficiency close to 1.0).

Dimmers were also often based on rheostats. These were inefficient; when set to the middle brightness levels, they could dissipate as heat a significant portion of the power rating of the load (up to 25% for resistive loads, more for temperature dependent loads like lamps) so they were physically large and required plenty of cooling air. Also, because their dimming effect depended a great deal on the total load applied to each rheostat, the load needed to be matched fairly carefully to the power rating of the rheostat.

3.7 Maintenance

Dust and dirty on lamps and fittings represent a loss in light, which may amount to as much as one-third of the rated output. Therefore regular cleaning and maintenance are essential to produce efficient performance.

For any large installation, random lamp renewals cleaning of the luminaries are certainly not the answer to problem if breakdowns are to be avoided. Cleaning provide the opportunity for vulnerable points, especially flexible cord connections.

3.8 Summary

In this chapter I gave details about types of lamp used for different lightning systems, the chapter contains their specifications, errors, advantages & comparisons with each other.

CONCLUSION

The aim of my project was to design and draw the electrical installation of a particular building and I think that I did it in a nice way, Actually I took this installation project because I worked in an electrical installation company here in Cyprus, so I was pretty much interested in the topics, because all of them are related with our normal life and as an electrical engineer those should be very well understood by me!

But when I choosed this project, I couldn't guess that I will face a lot of problems, because from the outside it can not be imagined. For a normal person who is not concerned with this installation stuff, it seems to him as if it is something simple but life is based on reality, information's are based on specific formulation. I tried to get information in detail because my purpose was to base my project on reality and according to standards.

In this project interior electric installation was drawn, after necessary information's were given for illuminating calculations for that, wire cross section were calculated with falling down of necessary voltage and calculating of current control.

Auto-Cad programmed has recently been a great development in drawing the electrical plans, so I also took help of it during my project, I used Auto-CAD 2004 version for this purpose, it was a bit tiring experience working with Auto-CAD program but at the same time it was very enjoying, because its related with my future, because what I think that these installation projects are the basics for a power engineer like me!

This project helped me to somehow predict for my career, for my profession, how challenging it can be, and how much professionalism is needed to handle projects like this one.

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